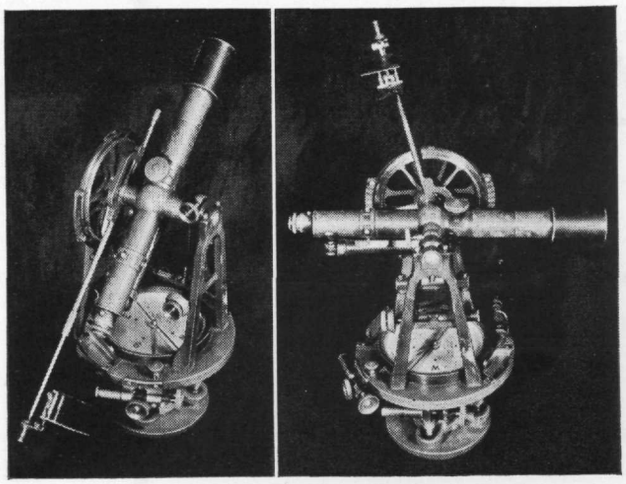
The Simplex SOLAR SHIELD

The Invention of Our Own Prof. Watt

By Raymond C. Schmitt



The shield in position (left) for solar reading and (right) out of the way, on a Berger Transit.

To grasp the full significance of any new invention one must see it in operation. During the course of last summer's surveying camp some of the fellows in the field parties had the opportunity of using an invention before it was even patented.

It was indeed a rare privilege to take part, a year ago on the campus, in one of the observations, using the Simplex Solar Shield. The methods and results were very convincing in their revolutionary treatment of solar observations.

A problem, which has seemed difficult for engineers and surveyors, was that of obtaining consistently accurate latitude and azimuth determinations from the sun, with the engineer's transit.

Many methods of observing have been devised and many statements have been made about procedure and precaution; until the average surveyor became so confused with the various techniques that he decided to continue to run his surveys on compass bearings or assumed azimuth.

But the modern survey demands that true direction be carried on the lines of the survey and that periodic checks be made to establish position on the earth's surface.

These facts led Professor C. H. Wall, Department of Civil Engineering, to investigate the problem thoroughly and to arrive at a definite conclusion, which was reached after 20 months of study.

The procedure consisted of establishing a base-line on the campus by precise triangulation, correct to five seconds in azimuth, in order to check the results of observations on the sun. Then hundreds of solar observations were made by the direct method or altitude method, employing most of the well-established methods of field procedure.

Detailed information was recorded about the visibility, the wind, the condition of the transit, the method of leveling and other factors affecting the final azimuth determination.

After a careful investigation of all of the results by the various methods of procedure, it was noted that consistently accurate results were lacking by any one method and that some means was necessary, whereby all of the objectionable features of the existing methods, could be eliminated.

This was accomplished after a two year period of intensive research, by designing not only the apparatus to insure accurate field data, but also to simplify and make foolproof the method of reduction, so that the final result would be dependable.

The sun provides a convenient means of obtaining direction or azimuth, not only because it affords light by which the instrumentman can observe and record his data, but because it produces a bright image which he can study close at hand. Professor Wall has taken advantage of these circumstances in his solution of the problem of obtaining accurate azimuth, and accurate latitude.

One complication is that the sun travels rather fast and therefore offers difficulties in pointing and also in timing. After considerable thought a method was found, making it possible both to secure accurate pointing on the center of the sun, and to guarantee accurate time intervals between successive pointings. As a result of a program of extensive

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Right—A Typical Data Sheet.

SOLAR AZIMUTH

Sun	Time	H.C.	Check	V.C.	Check
5D	E.S.T.	0° 00′	180°00′	(Base	Line)
5R	45′ Fast	180°00′	0°00′	(Base	Line)
1	3:19:04	331°08.1′		44°40.4′	
	46″		11.1′		8.3′ 7.5′
2	3:19:50	331°19.2′		44°33.0′	
	45″		10.8′		8.1′ 8.0′
③	3:20:35	331°30.0′		44°25.0′	
	46″		11.1′		8.3′ 8.0′
4	3:21:21	331°41.1′		44°16.7′	
	46″		11.1′		8.3′ 8.0′
5	3:22:07	331°52.2′		44°08.4′	
Mean	3.38	332°09.72′	0.241′/″	43°56.02′	0.181′/″
6	3:24:38	152°27.3′		43°44.6′	
	46″		11.1′		8.3′ 9.0′
7	3:25:24	152°38.4′		43°35.5′	
	46″		11.1′		8.3′ 8.5′
⑧	3:26:10	152°49.5′		43°27.0′	
	45″		10.8′		8.1′ 8.0′
9	3:26:55	153°00.3′		43°18.9′	
	45″		10.8′		8.1′ 9.0′
10	3:27:40	153°11.1′		43°10.8′	
	365″ For The Sun		To Travel	Vertically	66.0′

DIRECT METHOD

Data — Formula — Results

Observers Hall & Woodruff — Transit 69180

Date	Place	Weather	Temperature	Elevation
8-21-39	Columbus	Windy	80°F.	720

Longitude 83° 01.48′ — Latitude = 39° 59.27′

Sun's Declination D (Table I) = 12° 13.05′

Sun's Altitude h (Corrected) = 43° 55.19′

Sun's Diameter ● (31.70′) x 2 = 63.40′

$$\cos Zs = \tan h \cdot \tan L - \frac{\sin D}{\cos h \cdot \cos L}$$

tan h = .96299 }
tan L = .83874 } .80770

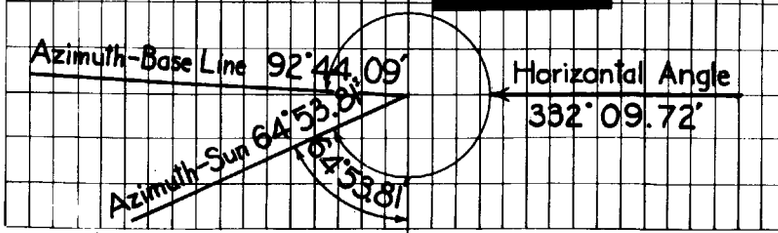
sin D = .21162 — .21162 — .38345

cos h = .72031 } .55189
cos L = .76618 } cos Zs = .42425

Sun's Azimuth ---------- 64°53.81′

Horizontal Angle ---------- 332°09.72′

Azimuth-Base Line ---------- 92°44.09′



365″ For The Sun To Travel Horizontally 2 Dia.-sech

The Simplex Solar Shield

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study a small shield of symmetrical design has been devised to be placed in front of a plate on which the sun's image and the cross-wires of the transit may be focused, as shown in Fig . The shape and size of this shield are such as to match the sun's image and facilitate successive timing as the image moves.

In operation the transit is set up and pointed in some arbitrary direction slightly in advance of the sun's position. As the sun comes into the field of the instrument, the shield casts a shadow on the plate; and it is this well-defined shadow with its notches, points, and holes, which enables the instrumentman to follow with his vertical tangent adjustment the sun's image as it travels across the plate, while recording the time and inclination-angle data necessary for azimuth computations.

The special advantages of this method are accurate pointings on the sun's center, and also accurate time intervals between pointings, which afford a check on the altitude readings, since the design of the shield easily facilitates these very important steps in field procedure. That is, the observer knows when to take the pointings, has ample time to record the necessary data, and is warned by the position of the image on the plate when to take the next pointing.

A complete observation utilizes five positions of the sun with the instrument in the direct position (Fig. ?); then five similar positions of the sun when the transit is reversed. This makes a total of ten pointings on the center of the sun, with accurate time intervals between.

If the latitude is not available from a map, the shield is again useful in obtaining data for an accurate latitude determination, because the sun can be observed in several positions before the meridian is reached; then in several positions after the meridian is crossed. Since the data obtained at these several positions are sufficient to give not only accurate vertical angles, but also accurate vertical rates of travel, it becomes a simple matter to compute the additional vertical rise in each case to arrive at the highest point on the curve, that is, at the meridian. The mean of these determinations, when properly combined with the sun's declination, gives the latitude accurately.

The shield lends itself to almost any established method of taking solar observations by the direct method. Briefly, the field procedure consists of orientation on the base line; then a careful adjustment of the shield for observation. The horizontal circle is set ahead of the first position at some convenient reading, which is readily checked, and remains clamped during the series of five pointings.

The vertical-angle slow-motion screw is operated to center the sun's image as it arrives at the several positions, for each of which the time and the vertical angles are recorded. The horizontal and vertical rate determinations then afford a valuable check on the observed angles when this rate is combined with the corresponding time intervals, thereby providing field data that will insure accuracy in the final direction of the line.

Those attending the Engineer's Day festivities this coming May 10-11, will have the privilege of seeing the Simplex Solar Shield in action. It is a coincidence that the Academy of Science will hold its semi-centennial celebration in Columbus on May 9-10-11. The Armory on the Ohio State University campus will be given over to housing the exhibits.

One of the exhibits will be a continuous five minute showing of the solar devise, illustrating how the sun travels across the shield to obtain accurate pointing and timing. Whereas the shield is 1" square in actual size it will be be projected as 3 feet square on the screen. Transits will be set up with the attachment and additional shields will be available for closer inspection. Mr. Wall will be on hand to explain the procedure and answer any questions that may arise.

Passage of the Sun Across the Shield.